Requirements, Capabilities and Analysis for Earth Observations (RCA-EO)

Project Update for the Landsat Science Team

July 26th, 2016

U.S. Department of the Interior
U.S. Geological Survey

Outline

- Purpose of RCA-EO

- OSTP Earth Observation Assessment (EOA)

- User Requirement Examples

- What's next

Purpose of RCA-EO

RCA-EO provides data and analyses to help optimize investments in Earth observing technology and products to better meet user needs
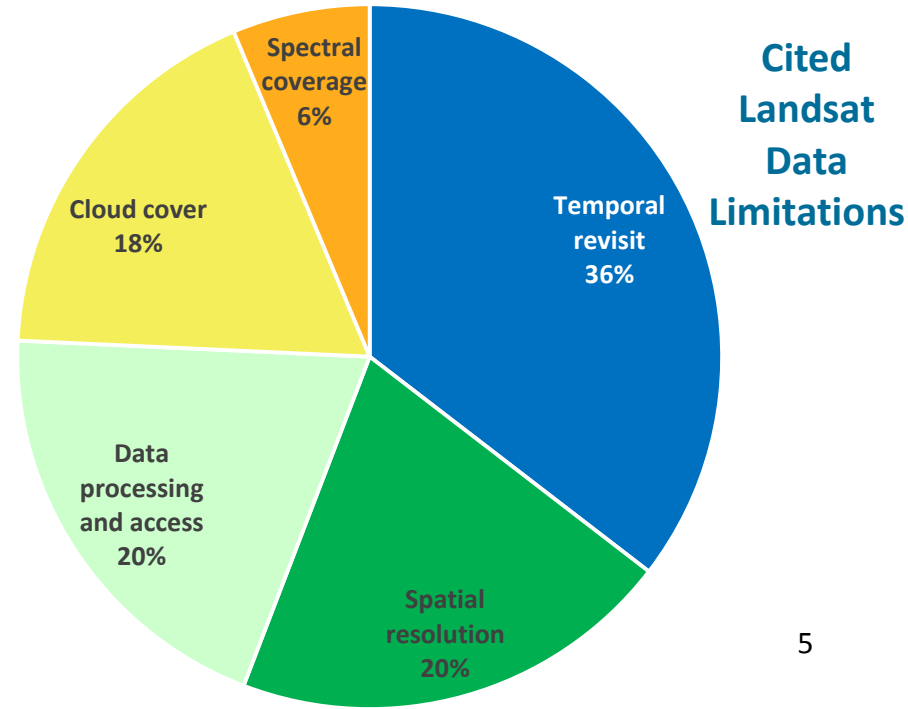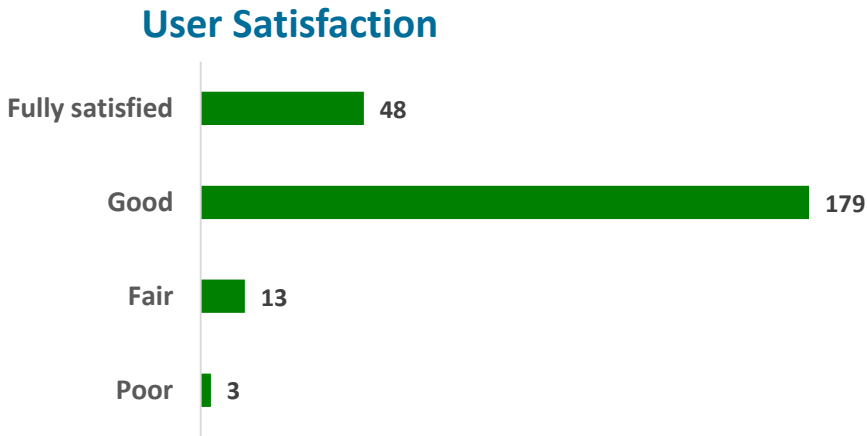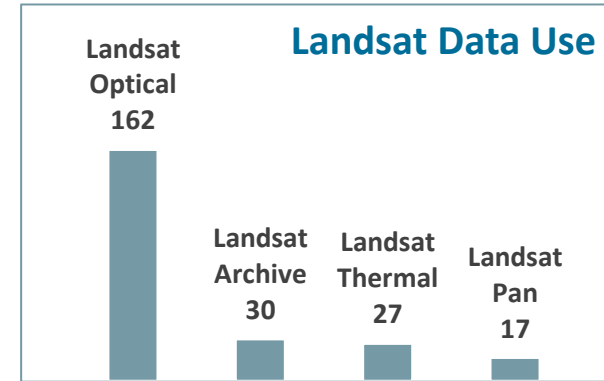
Federal Earth Observation Assessment

- OSTP-led snapshot of Earth observation (EO) data use across Federal Civil Agencies

  - Current portfolio of EO systems relied on by the Federal government organized by 13 societal benefit areas

  - ~1750 key products surveyed

  - Landsat is a direct ingredient in 174 products

- Identified user satisfaction and limitations for currently used data sources

- Working to analyze the breadth/depth of Landsat community covered by this data

Landsat use from EOA 2016

- Preliminary results based on current snapshot Federal civil Landsat users

- 174 key products from multiple Federal agencies

- Most people use more than one type of Landsat data, and are generally satisfied with Landsat data, but did identify some limitations

- Temporal revisit was the most often cited limitation

- Users also identified needs for higher spatial resolution, additional processing, and mosaic products

Landsat Data Use

Landsat Optical 162
Landsat Archive 30
Landsat Thermal 27
Landsat Pan 17

User Satisfaction

Fully satisfied 48
Good 179
Fair 13
Poor 3

Cited Landsat Data Limitations

Temporal revisit 36%
Spatial resolution 20%
Data processing and access 20%
Cloud cover 18%
Spectral coverage 6%

5

Building on the EOA:
User Requirements Elicitation - Approach

- Data collection is underway to document user requirements

  – Initial focus on Landsat applications identified in RCA-EO and EOA 2016 information

- Applications that rely on a broader range of land imaging platforms/sensors will be added

- Continue to fine-tune collection priorities/activities

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Requirements capture

- Requirements captured by variable or "environmental parameter"
  - The fundamental information being observed
  - Some examples:

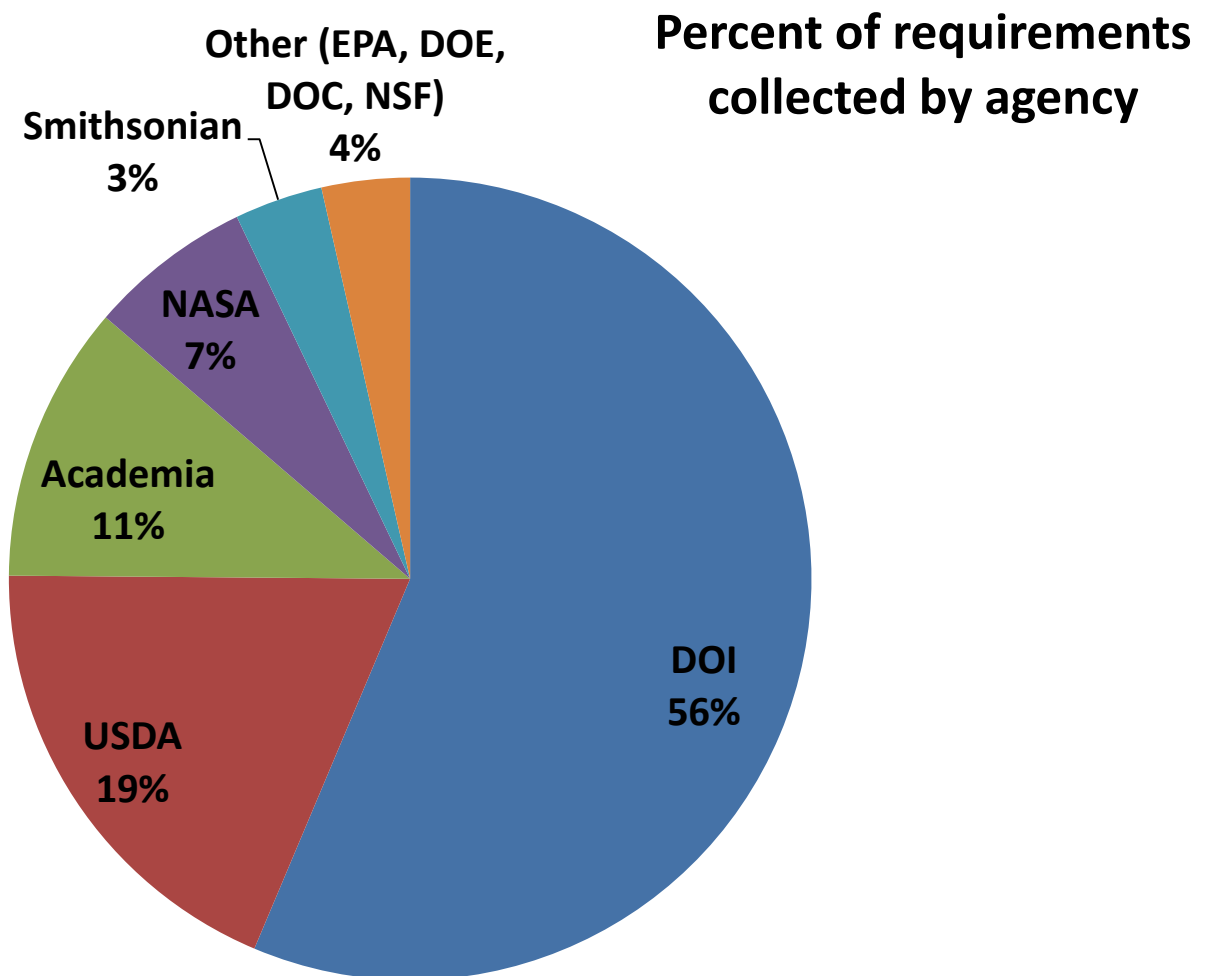| |
|---|
| **Land Cover** |
| **Vegetation Condition** |
| **Burned Area Extent** |
| **Biomass: Vegetation** |
| **Terrain Elevation** |
| **Land Skin Temperature** |
| **Surface Reflectance** |
| **Surface Water Extent** |
| **More....** |

Requirement Attributes

- For each Environmental Parameter, a variety of attributes are captured:

    – Geographic Coverage

    – Horizontal Resolution

    – Vertical Resolution (if applicable)

    – Sampling Interval

    – Accuracy

    – Data Latency

    – Conditions for Sampling

    – Length of the Data Record

    – Spectral Characteristics

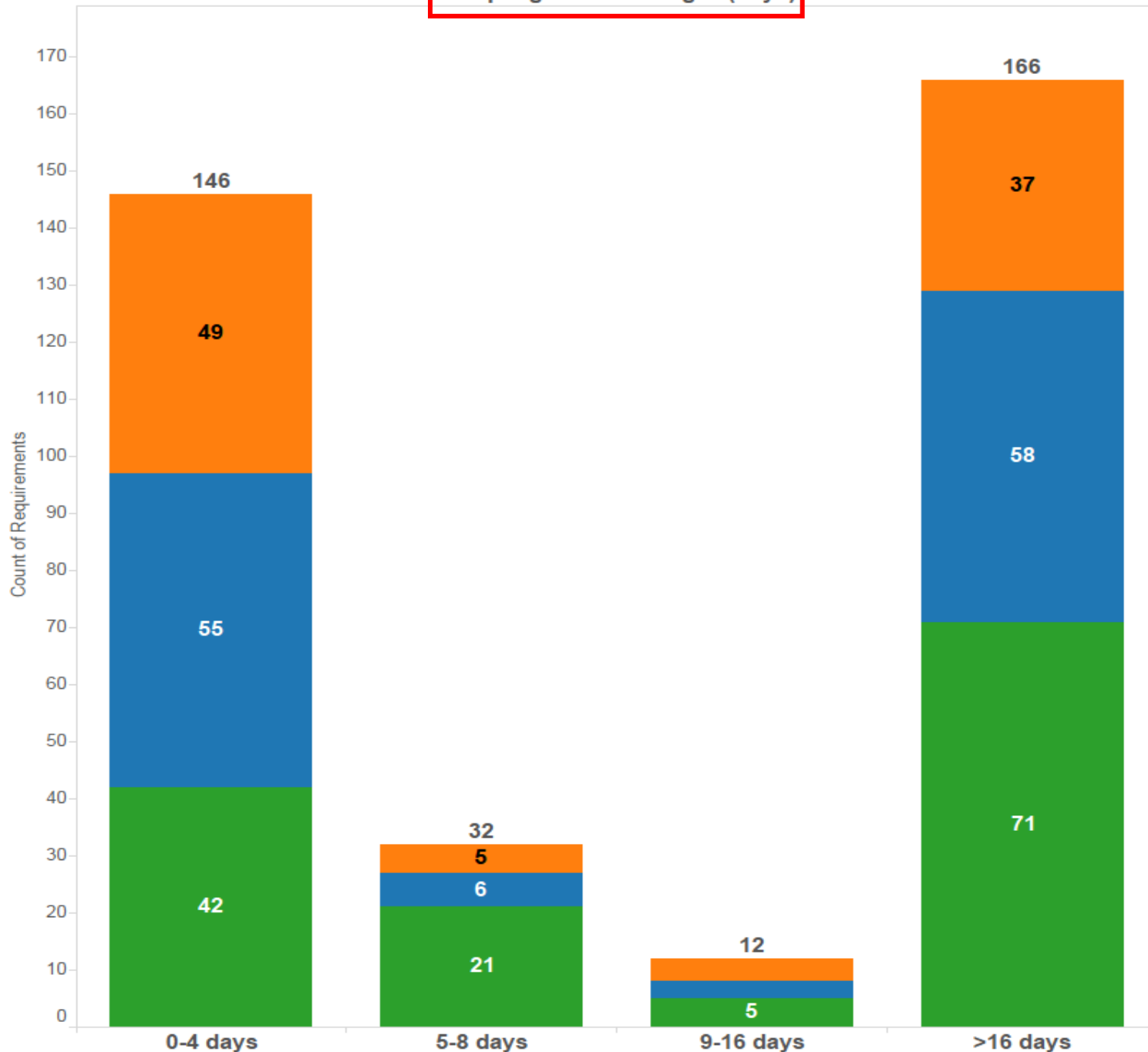   – Data Services, Access and Formats

User Requirements

- For each requirement there are 3 potential levels:

  - **Threshold**

    - The minimum specification to be met to ensure that an Earth observation dataset or service is useful

  - **Breakthrough**

    - An intermediate requirement level which, if achieved, would result in a significant improvement in capability against the targeted application

  - **Target**

    - The value above which further improvement of the EO dataset or service would provide only limited improvement in performance for the application in question

Initial Requirements Collection

Percent of requirements collected by agency

- Other (EPA, DOE, DOC, NSF) 4%
- Smithsonian 3%
- NASA 7%
- Academia 11%
- USDA 19%
- DOI 56%

Sampling Interval Ranges (days)

Histogram Selector
Sampling Interval (days) ▼

Geo Coverage
No Specific Geo Coverage ▼

Requirement Set Name
(All) ▼

Environmental Parameter Topic
(All) ▼

Environmental Parameter Term
(All) ▼

Primary Variable
(All) ▼

Secondary Variable
(All) ▼

Requirement Level
(All) ▼

Data Latency (days)
Real Time   365.0

Horizontal Resolution(m)
0   100000

Sampling Interval (days)
Real Time   7300

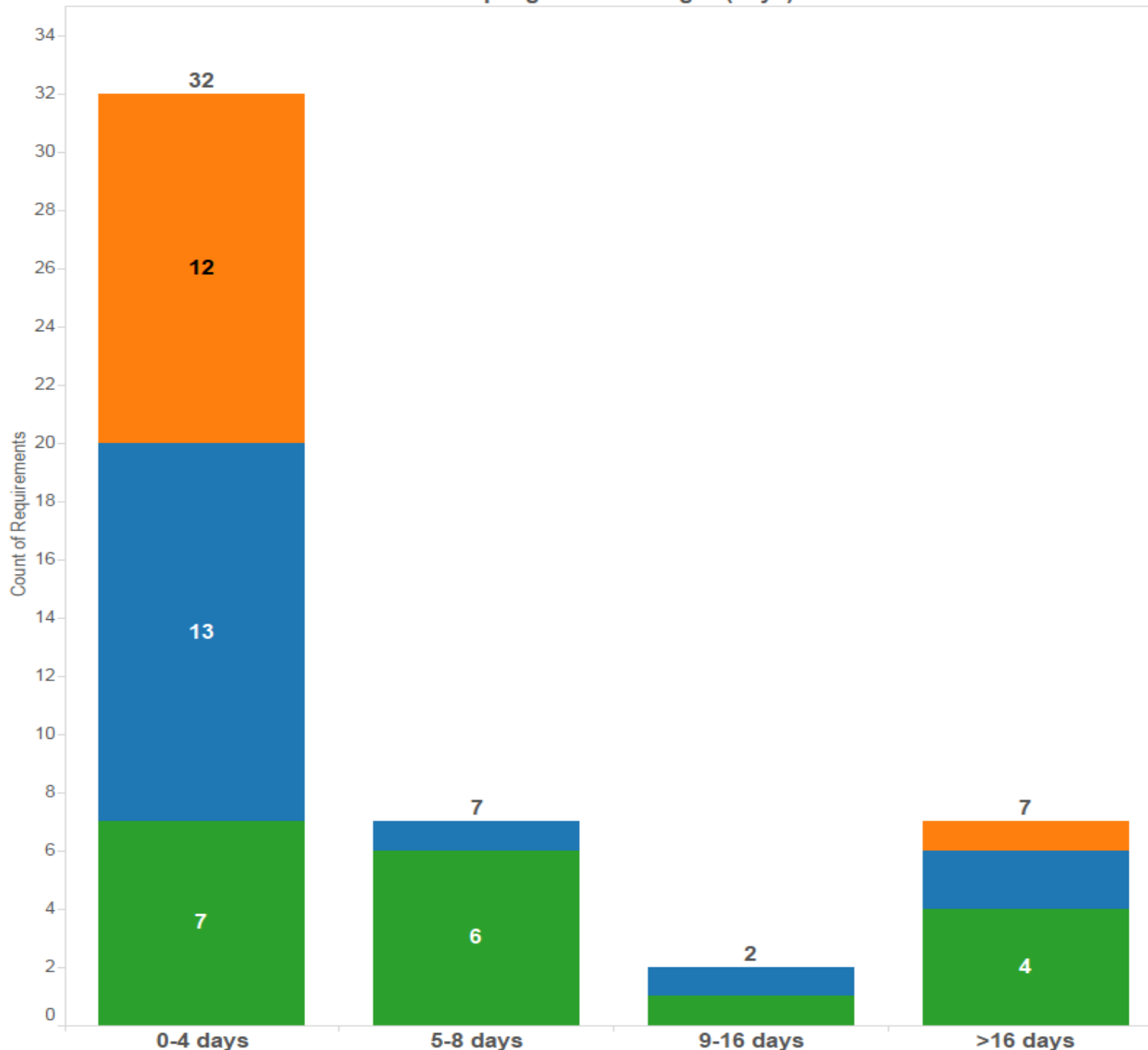**Count of Requirements**
603

Percent of Requirements
100.00%

Requirements Level:
🟧 Target
🟦 Breakthrough
🟩 Threshold

Sampling Interval Ranges (days)

Sampling Interval Ranges (days)

Histogram Selector	
Sampling Interval (days)	▼

Geo Coverage
| No Specific Geo Coverage | ▼ |

Requirement Set Name
| (All) | ▼ |

Environmental Parameter Topic
| (All) | ▼ |

Environmental Parameter Term
| (All) | ▼ |

Primary Variable
| VEGETATION CONDITION | ▼ |

Secondary Variable
| (All) | ▼ |

Requirement Level
| (All) | ▼ |

Data Latency (days)
Real Time   365.0

Horizontal Resolution(m)
0   100000

Sampling Interval (days)
Real Time   16.00

Count of Requirements
41

Percent of Requirements
6.80%

Requirements Level:
■ Target
■ Breakthrough
■ Threshold

Horizontal Resolution Ranges (m)

Histogram Selector
Horizontal Resolution(m) ▼

Geo Coverage
No Specific Geo Coverage ▼

Requirement Set Name
(All) ▼

Environmental Parameter Topic
(All) ▼

Environmental Parameter Term
(All) ▼

Primary Variable
(All) ▼

Secondary Variable
(All) ▼

Requirement Level
(All) ▼

Data Latency (days)
Real Time   365.0

Horizontal Resolution(m)
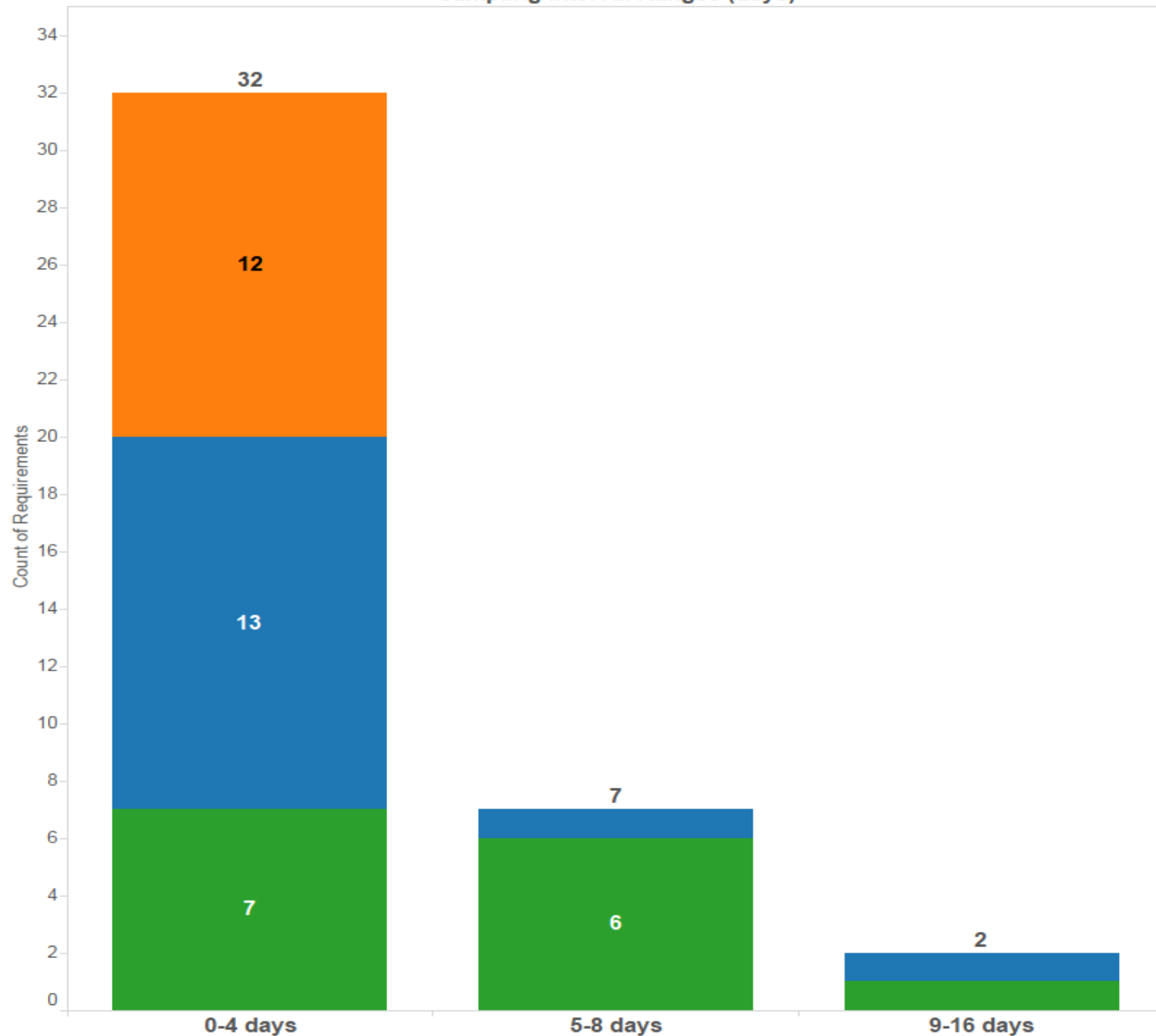0   100000

Sampling Interval (days)
Real Time   7300

Count of Requirements
603

Percent of Requirements
100.00%

Requirements Level:
■ Target
■ Breakthrough
■ Threshold

Horizontal Resolution Ranges (m)

Histogram Selector
Horizontal Resolution(m) ▼

Geo Coverage
No Specific Geo Coverage ▼

Requirement Set Name
(All) ▼

Environmental Parameter Topic
(All) ▼

Environmental Parameter Term
(All) ▼

Primary Variable
LAND COVER ▼

Secondary Variable
(All) ▼

Requirement Level
(All) ▼

Data Latency (days)
Real Time — 365.0

Horizontal Resolution(m)
0 — 100000

Sampling Interval (days)
Real Time — 7300

Count of Requirements
81

Percent of Requirements
13.43%

Requirements Level:
- Target (orange)
- Breakthrough (blue)
- Threshold (green)

Horizontal Resolution Ranges (m)

Histogram Selector
Horizontal Resolution(m)

Geo Coverage
No Specific Geo Coverage

Requirement Set Name
(All)

Environmental Parameter Topic
(All)

Environmental Parameter Term
(All)

Primary Variable
LAND COVER

Secondary Variable
(All)

Requirement Level
(All)

Data Latency (days)
Real Time   365.0

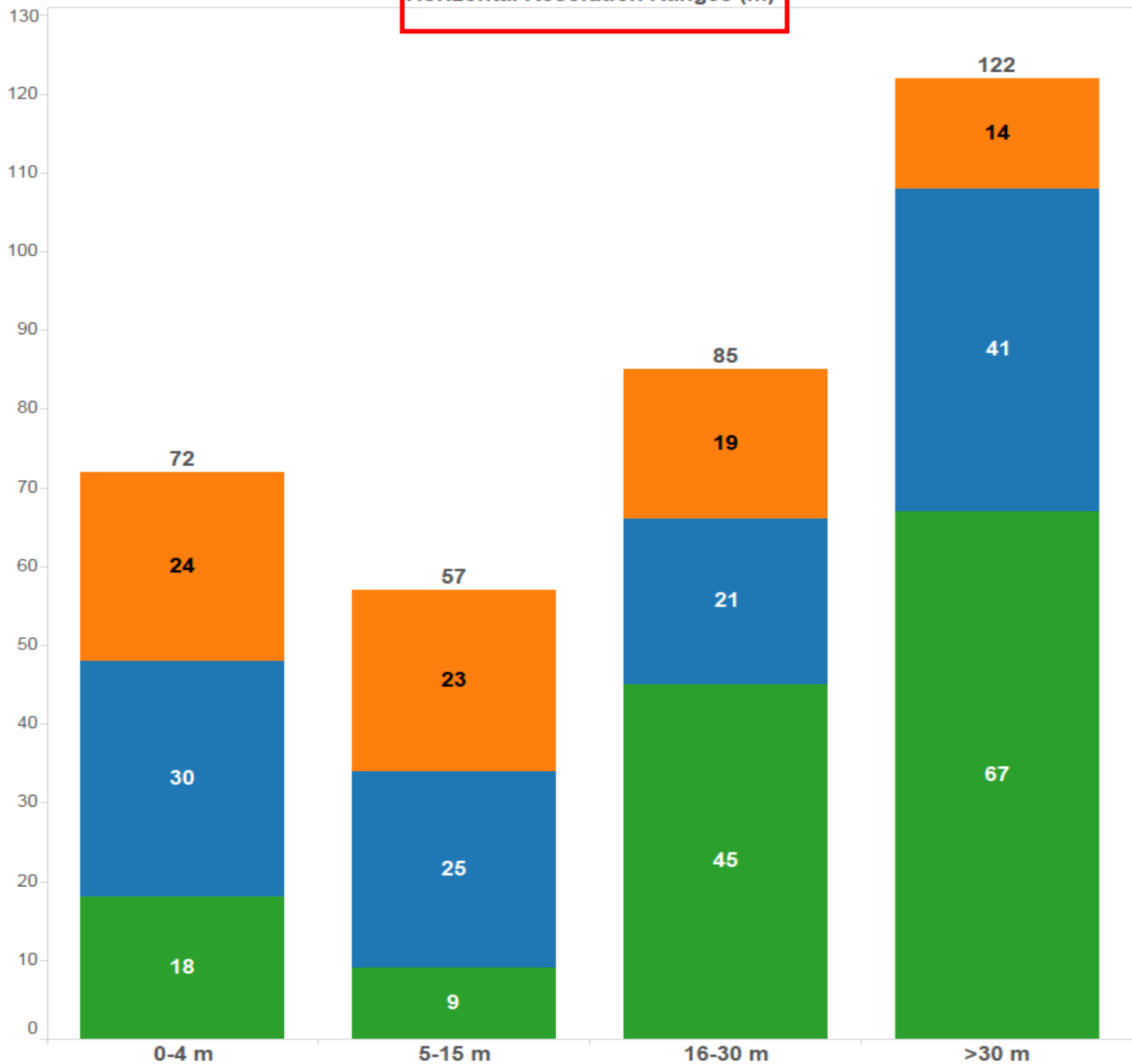**Horizontal Resolution(m)**
0.00   30.00

Sampling Interval (days)
Real Time   16.00

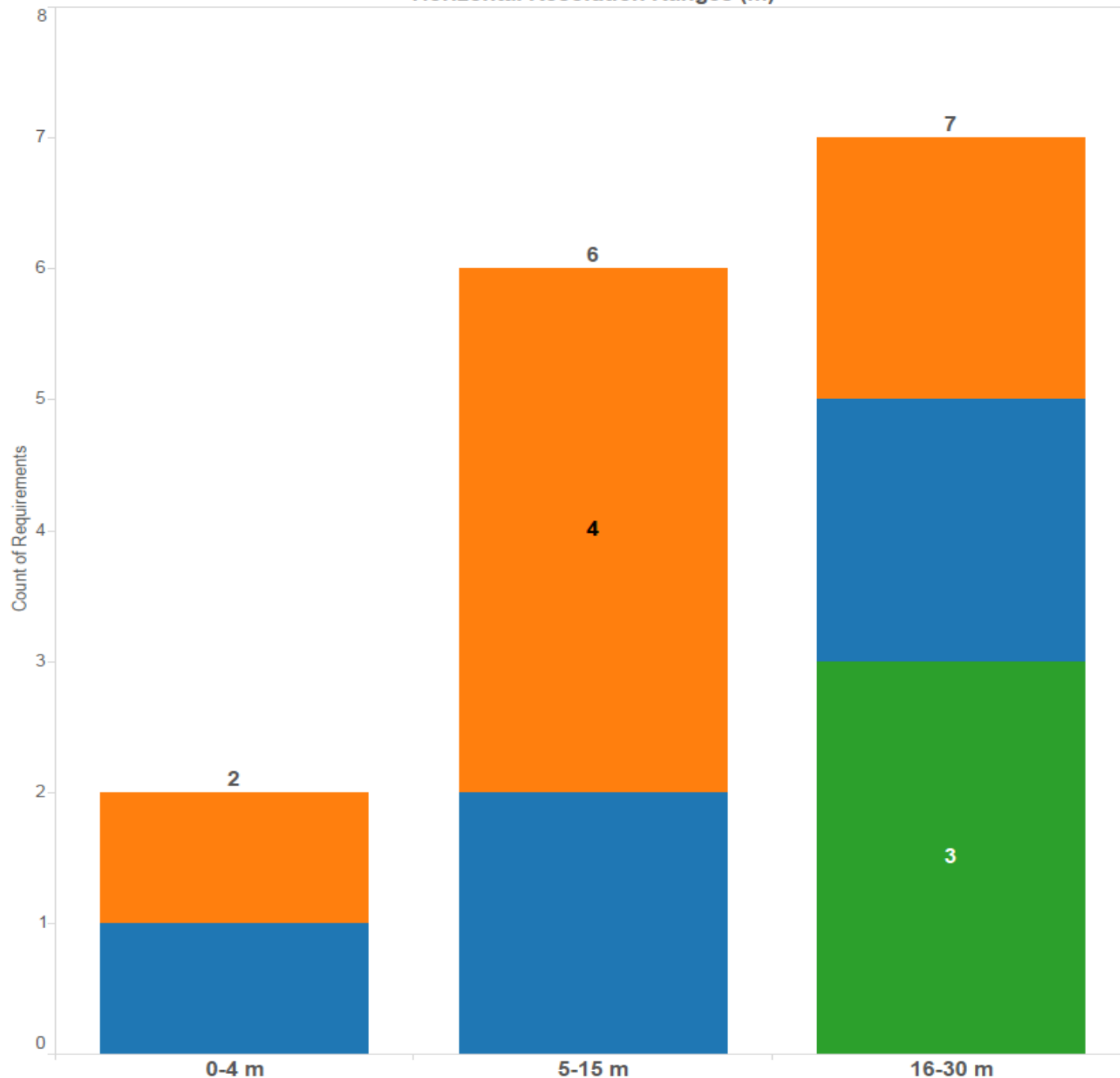Count of Requirements
15

Percent of Requirements
2.49%

Requirements Level:
Target
Breakthrough
Threshold

Base Requirements:

Filters:

Application Area
[(All) ▼]

Environmental Parameter ..
[(All) ▼]

Environmental Parameter ..
[(All) ▼]

KPS
[(Multiple values) ▼]

Primary Variable
[(All) ▼]

Secondary Variable
[(All) ▼]

Requirement Level
- ☐ (All)
- ☑ Threshold
- ☐ Breakthrough
- ☐ Target

KPS	Primary Variable	Horizontal Resolution(m)	Sampling Interval (days)
Coastal Wetland Ecology Research - Domestic	BIOMASS: VEGETATION		
	LAND COVER		
	SURFACE WATER EXTENT		
	TERRAIN ELEVATION		
Coastal Wetland Ecology Research - Global	BIOMASS: VEGETATION		
	LAND COVER		
	SURFACE WATER EXTENT		
	TERRAIN ELEVATION		
Permafrost and Land Surface Property Mapping	LAND COVER		
	LAND SKIN TEMPERATURE		
	TERRAIN ELEVATION		
Water Use Estimates from Irrigated Lands	CROP TYPE		
	LAND SKIN TEMPERATURE		
	LAND USE/LAND COVER CLASSIFICATION		
	SOIL MOISTURE/WATER CONTENT: SURFACE		
	SURFACE REFLECTANCE		
	VEGETATION CONDITION		

Horizontal Resolution(m) axis: 1, 10, 100, 1000
Sampling Interval (days) axis: 1, 10, 100, 1000

Legends:

Requirement Level
☐ Threshold

Horizontal Resolution (m)
- ■ Does Not Meet Requirem..
- ■ Within 20% of Requireme..
- ■ Exceeds Requirements

Sampling Interval (days)
- ■ Does Not Meet Requirem..
- ■ Exceeds Requirements
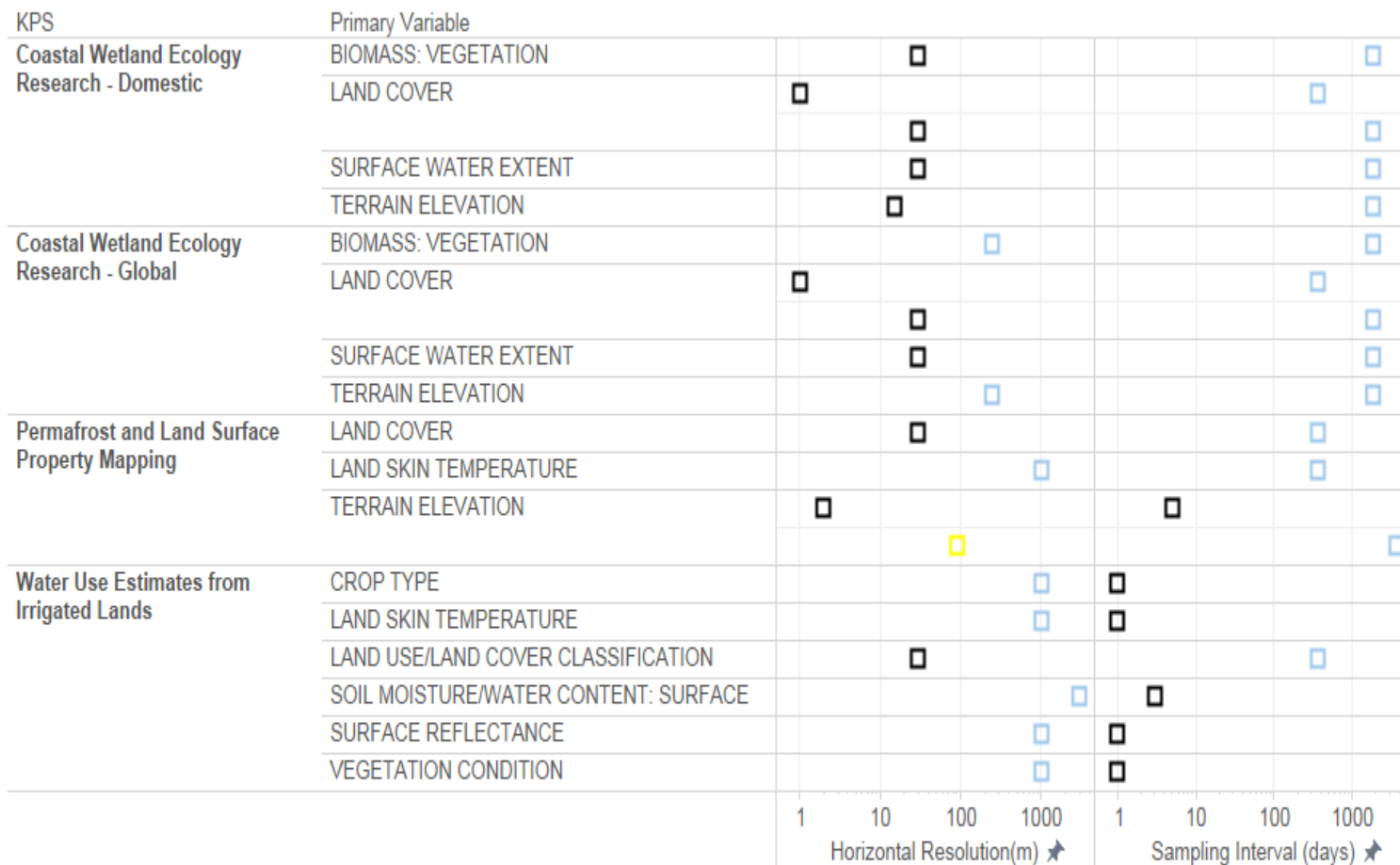
How representative is our RCA-EO data Landsat

- How representative are Federal needs compared to non-Federal users?

- Few differences exist between the relative percentages of Federal users and other users, in primary applications

- However, Federal users are underrepresented in common applications: education, agriculture, and geology

- And, there may be differences in user requirements within applications where no significant differences were found in this analysis

- Next steps…

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Are their many unique non-Federal Landsat requirements?

- Is their existing research on or knowledge of requirements that indicates variations?
  - If so, further requirements gathering outside of U.S. Federal users may be needed

- Potential sources of requirements information
  - NGAC, AmericaView, Landsat Science Team
  - RFI Process
  - Other methods in concert with OMB collection rules

What's ahead for L 10 requirements Development

- Continue building set of user requirements across the broader range of land imaging applications

  – Hyperspectral applications

  – Additional thermal applications

  – Higher resolution applications (~5-20 m range)

  – Higher revisit applications

- Developing approach to analyze requirements

  – Compare user requirements to potential L 10 configurations; which requirements are met?

    - NASA L10 engineering models

    - Notional systems with expanded resolution or spectral bands

    - Other ideas?

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Comments?

Backup

Requirements Trend Animated Example

Illustrative Only
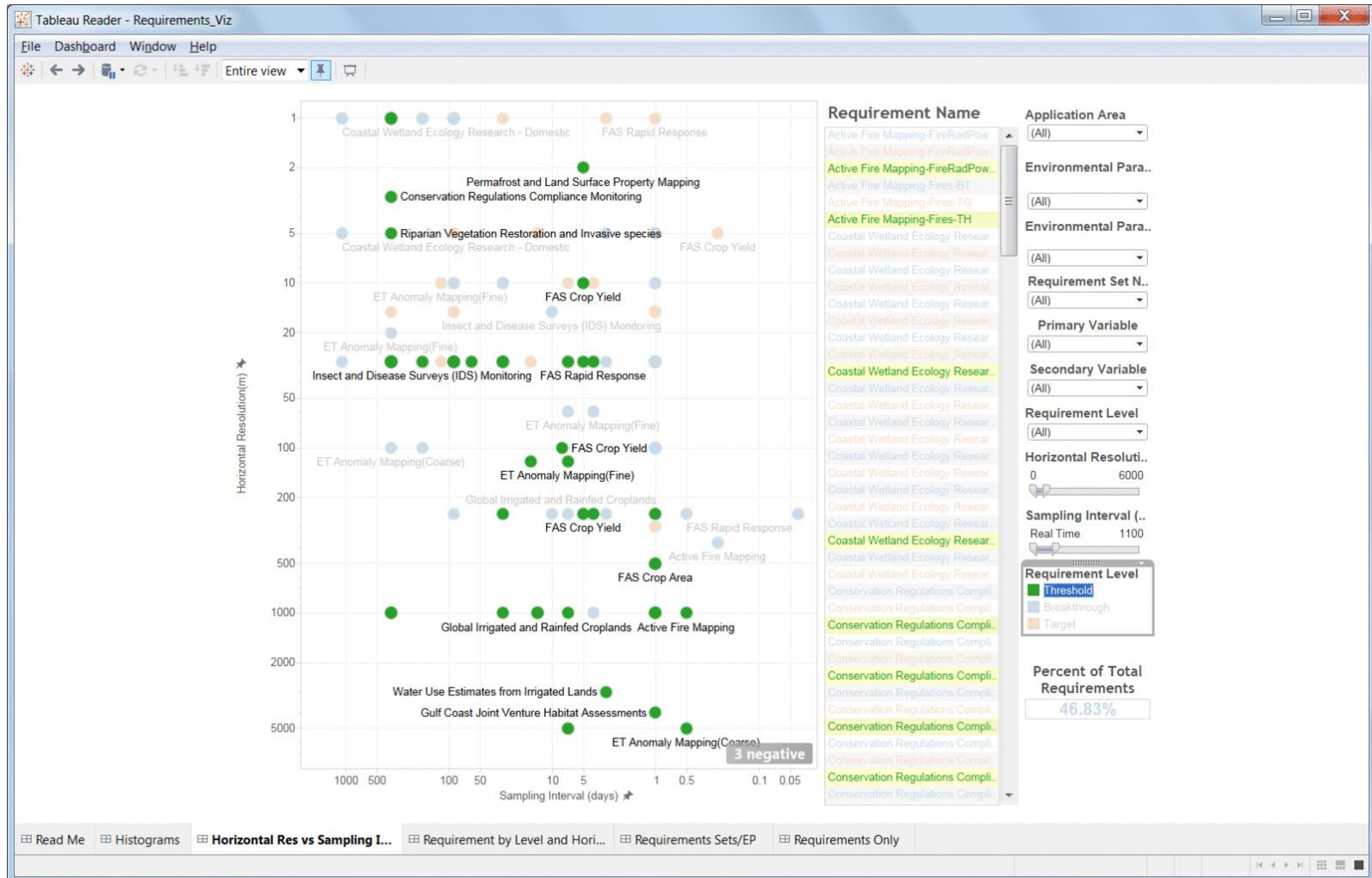
Key Products/Services	SME Organization
Habitat Mapping Analysis	DOI FWS
Refuge Wetland Mapping	DOI FWS
Wildlife Refuge Landscape Management	DOI FWS
National Park Landcover Change Monitoring	DOI NPS
NPS Hydraulic Modeling and Monitoring	DOI NPS
Arctic Boreal Vulnerability Experiment	NASA
Carbon Dynamics	NASA
Vegetation Structure and Function	NASA
Surface Water Extent and Dynamics	NASA
Permafrost and Hydrology	NSIDC
ET Anomaly Maps (Coarse Scale)	USDA ARS
ET Anomaly Maps (Fine Scale)	USDA ARS
Crop Residue Monitoring	USDA ARS
Global Crop Area Estimation	USDA FAS
Global Crop Yield Estimation	USDA FAS
Rapid Response to Global Agricultural Crises	USDA FAS
Global Lake and Reservoir Levels	USDA FAS

Key Products/Services	SME Organization
Tree Canopy Cover	USDA Forest Service
Active Fire Mapping	USDA Forest Service
Burned Area Reflectance Classification (BARC)	USDA Forest Service
FIRESEV	USDA Forest Service
Monitoring Trends in Burn Severity (MTBS)	USDA Forest Service
Rapid Assessment of Vegetation Condition (RAVG)	USDA Forest Service
Baseline Forest Inventory and Analysis (FIA) Forest Inventory	USDA Forest Service
Insect and Disease Detection Surveys (IDS) - Modeling	USDA Forest Service
Insect and Disease Detection Surveys (IDS) - Monitoring	USDA Forest Service
Land Change Monitoring System (LCMS)	USDA Forest Service
Regional Scale Forest Vegetation Mapping	USDA Forest Service
Crop Area and Yield	USDA NASS
OpTIS Operational Tillage Information System (Crop Residue Management Survey)	USDA NRCS
SSURGO/STATSGO - soil mapping	USDA NRCS
Actuarial Rate Maps	USDA RMA
Compliance Monitoring Investigations	USDA RMA
Permafrost and Land Surface Property Mapping	USGS

Key Products/Services	SME Organization
Vegetation Dynamics and Distribution	Academia, U of CA Irvine
Wildlife and Ecosystem Services (ABoVE - Animals on the Move)	Academia; Columbia University, U of Idaho
Vegetation Structure and Function	Academia; Montclair University
Lake Clarity Monitoring	Academia; U of Minnesota
Forest Tundra Ecotone structure and function	Academia; U of Idaho
Global Forest Cover Change	Academia; U of MD
Tundra Fires	Academia; U of MD
Carbon Dynamics	Academia; U of MT
Inland Water Dissolved Organic Carbon, and CO2 CH4 emissions	Academia; U of WA
Emergency Stabilization and Rehabilitation Plans (BLM) - Also called BAER	DOI BLM
Sage Grouse Conservation - Landscape Scale	DOI BLM
Sage Grouse Conservation - Project Scale	DOI BLM
Consumptive Water Use	DOI BOR
Estimates of Evapotranspiration and Evaporation (formerly LCRAS reports)	DOI BOR
Conservation Regulations Compliance Monitoring	DOI FWS
Bi-National Wetland Classification Mapping	DOI FWS
Gulf Coast Joint Venture Habitat Map	DOI FWS

Key Products/Services	SME Organization
Permafrost and Hydrology	USGS
Wetland Coastal Change Studies	USGS CMGP
Marsh Equilibrium Model	USGS EP
Salt Marsh Carbon Cycling Research	USGS EP
Coastal Wetland Ecology	USGS EP
Gulf Coast Marsh Classification Map	USGS EP
Herbaceous Biomass	USGS EP
Post-Fire Shrub Recovery	USGS EP
Remote sensing of oil on water - Littoral Zone	USGS MRP
Remote sensing of oil on water - Open Ocean	USGS MRP
Chesapeake Bay Project Remote Sensing of Winter Ground Cover	USGS LCS
National-Scale Wildfire and Fire Management Impacts on Ecosystem Carbon Storage and Greenhouse Gas Emissions	USGS LCS
Global Irrigated and Rainfed Croplands	USGS LRS
Irrigation Monitoring-ET and Remote Sensing	USGS LRS
Land Remote Sensing Environmental Applications - Color of Dissolved Organic Matter or Other Materials	USGS LRS
Alaska Minerals Mapping	USGS MRP
Surface Minerals Mapping	USGS MRP
Mineral Mapping	USGS MRP
Louisiana Coastwide Reference Monitoring System (CRMS)	USGS S&T
Boreal Fires (Fire-Climate Forcings)	Woods Hole

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Example Application Areas (First 70)

Ag Forecasting	7
Agricultural management/production/ conservation	3
Climate science/change	7
Coastal science/monitoring/ management	2
Ecological/ecosystem science/management	11
Emergency/disaster management	2
Fire science/management	8
Fish and wildlife science/management	8
Forest science/management	7
Hazard insurance (crop, flood, fire, etc.)	2
Oil and gas/mineral exploration/extraction	3
Recreation science/ management	1
Water resources (watershed management, water rights, hydrology)	10

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2016 Requirements Collection Plans (example)

- **FY16 Requirements collection to include key land imaging activities within:**
  - USGS, USDA, BLM, BOR, FWS, NPS, NASA and potentially other agencies

- **USDA applications & subject matter experts to be surveyed (examples only):**
  - **NRCS:** Crop Residue Management Surveys, Soil Survey Interpretation Maps, National Resource Inventory (NRI); Sample SMEs: Dorsey Plunk, Tony Kimmet, Dan Good, Dave Hoover
  - **FAS:** Global Crop Area/Yield Estimation, Rapid Response to Global Agricultural Crises; Sample SMEs: Bob Tetrault, Curt Reynolds, Glenn Bethel
  - **RMA:** Actuarial Rate Maps, Compliance Monitoring Investigations; Sample SME: Jim Hipple
  - **NASS:** National Crop Yield Forecasting Sample SMEs: Rick Mueller, David Johnson
  - **ARS:** ET Anomaly Mapping, National Watershed Climate Change; Crop Residue Monitoring; Sample SMEs: Martha Anderson, Craig Daughtry, Mark Walbridge
  - **Forest Service:** Global Forest Resource Assessment, Fire Products (BAER/BARC, MTBS, RAVG, Active Fire Mapping, Spatial Fire Behavior Models, etc.), Forest Disturbance Assessment, National Insect and Disease Risk Mapping, Forest Inventory and Analysis; Sample SMEs: Brad Quayle, Greg Dillon, Jim Ellenwood, Frank Krist, Frank Sapio, Bob Ilgenfritz

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Base Requirements:

Horizontal Resolution (m)
100

Sampling Interval (days)
60.00

Filters:

Application Area
(All)

Environmental Parameter..
(All)

Environmental Parameter..
(All)

KPS
(Multiple values)

Primary Variable
(All)

Secondary Variable
(All)

Requirement Level
- ☐ (All)
- ☑ Threshold
- ☐ Breakthrough
- ☐ Target

Legends:

Requirement Level
☐ Threshold

Horizontal Resolution (m)
- ■ Does Not Meet Require..
- ■ (yellow) Within 20% of Requirem..
- ■ (blue) Exceeds Requirements

Sampling Interval (days)
- ■ Does Not Meet Require..
- ■ (blue) Exceeds Requirements

KPS	Primary Variable	Secondary Variable
Coastal Wetland Ecology Research - Domestic	BIOMASS: VEGETATION	
	LAND COVER	VEGETATION SPECIES
		VEGETATION TYPE
	SURFACE WATER EXTENT	
	TERRAIN ELEVATION	
Coastal Wetland Ecology Research - Global	BIOMASS: VEGETATION	
	LAND COVER	VEGETATION SPECIES
		VEGETATION TYPE
	SURFACE WATER EXTENT	
	TERRAIN ELEVATION	
Permafrost and Land Surface Property Mapping	LAND COVER	VEGETATION TYPE
	LAND SKIN TEMPERATURE	
	TERRAIN ELEVATION	SURFACE SUBSIDENCE
		TOPOGRAPHY
Water Use Estimates from Irrigated Lands	CROP TYPE	
	LAND SKIN TEMPERATURE	
	LAND USE/LAND COVER CL..	
	SOIL MOISTURE/WATER CO..	
	SURFACE REFLECTANCE	
	VEGETATION CONDITION	

Horizontal Resolution(m): 0.01 — 1 — 100 — 10000 — 1000000

Sampling Interval (days): 0.1 — 1 — 10 — 100 — 1000

Application Areas that use Landsat by Organization In-work

Application Area	DOI	USDA	EPA	DOE	DOC	NASA	NSF	SI	Academia
Agriculture	Covered	Covered				Expected			
Cryosphere	Expected			Expected		Covered	Expected		Covered
Climate	Covered				Expected	Covered			Expected
Coastal	Covered								
Ecology	Covered	Expected				Expected		Expected	Covered
Energy	Expected			Expected					
Fire	Expected	Covered							Expected
Fish and Wildlife	Covered					Expected		Expected	Covered
Forests	Covered	Covered							Covered
Geology	Covered								
Human Needs	Expected	Expected				Expected			Covered
Legal/Security	Expected								Expected
Planning and Development	Covered	Expected							Expected
Recreation	Covered								
Water	Covered	Covered	Expected		Expected	Expected			Covered

Legend: Covered thus far (dark green) — Expected by Nov 2016 (light green)

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